

Legs and body beneath brown, very densely clothed with long yellow-brown hair.

Antennae almost exactly as in the specimen of *P. conjungens* labeled as the type in the collection of the Academy of Natural Sciences of Philadelphia, except in the proportions of antennal joints 1 to 3, which are 1.2, 0.3, and 1.0 mm. in length, respectively, as compared with 0.7, 0.25, and 0.8 mm. in the type.

*Type locality*.—Between Lebec and Saugus, in Los Angeles County, Calif., in the Sierra Madre Mountains. Collected by R. D. Lusk.

*Type*.—Male in the collection of the Los Angeles Museum. This specimen was lent to me for study by L. J. Muchmore.

Among Mr. Lusk's effects the following data, attached to a letter of inquiry from Mr. Muchmore, were found by Earl Hakes: "Found on the 22d day of January, 1933, about 7 miles this side of the summit on the Ridge Route. There were hundreds of these bugs flying through the air just below the snow line about 5 P. M."

This variety, while close to *P. conjungens* in most respects, seems to differ from the typical form enough to justify at least a varietal name. It may be separated from *conjungens* by the color, different shape of the ocular canthi, the more parallel sides of the horn of the vertex, the extreme hairiness of the head and anterior part of the pronotum, the heavily punctate anterior median impression, and the slightly different proportions of the first 3 antennal joints.

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## ON THE IDENTITIES OF CHALCIDOID TICK PARASITES (HYMENOPTERA).

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The discovery that Rocky Mountain spotted fever, a tick-borne disease, has become established in several widely separated sections of the United States and is becoming an increasingly important problem, has stimulated a keen interest in the natural enemies of ticks.

So far as known the only important insect enemies of ticks are minute chalcidoids belonging to the family Encyrtidae. The first record of one of these parasitic insects attacking a tick was published by L. O. Howard (1) in 1907 when he described *Ixodiphagus texanus*. The following year Howard (2) described a second genus and species from Texas which he called *Hunterellus hookeri* and in 1912 *Ixodiphagus caucurtei* was named and described by R. du Buysson (5) from France. A paper by R. A.

Cooley (19) published in 1929 apparently implies (p. 267) that all three of these names refer to the same insect. As will be shown later, however, *Ixodiphagus texanus* and *Hunterellus hookeri* are quite distinct species while *I. caucurtei* is identical with *Hunterellus hookeri*.

In another article by Prof. Cooley (20) published in 1930 and giving an account of his trip to Africa for the purpose of investigating tick parasites, it is stated that G. A. H. Bedford of the Veterinary Research Laboratory at Onserpooort, Transvaal, had discovered a chalcid that attacked adult ticks. It is also related that Dr. L. E. Robinson, parasitologist of the Cooper Technical Bureau, some years previously had received a box of adult *Amblyomma hebraeum* Koch from Cape Province and that upon being opened later in England the box was found to contain adult chalcids that had emerged in transit and which were different from the species discovered by Bedford. The conclusion is drawn that it is reasonably certain that there exist in Africa two new chalcidoid parasites of ticks. A review of tick parasite work published by Prof. Cooley (21) later in the same year, however, stated that the alleged tick parasite discovered by Bedford had been identified by the present writer as *Mormoniella vitripennis* (Walker), a common parasite of blowflies, and was probably not a parasite of ticks at all. The same review indicated that attempts to obtain examples of the supposed tick parasite taken by Robinson had failed and the identity of the species could not be established.

At present therefore only two species of tick parasites are definitely known to exist, viz, *Ixodiphagus texanus* Howard and *Hunterellus hookeri* Howard. These two species bear a close resemblance to each other and may easily be confused if examined only superficially. Both are small, robust, black species, with the antennae 11-jointed and clavate in the female, 10-jointed and nearly filiform or weakly clavate in the male; head as broad as thorax, broadly but not deeply concave behind; eyes distinctly hairy; mesoscutum weakly shagreened and uniformly clothed with rather coarse hairs; wings normal in size, the marginal vein about as broad as long, stigmal about as long as marginal and post-marginal combined, oblique hairless streak from stigmal vein distinct; propodeum medially very short; abdomen broader than long, shorter than the thorax, the ovipositor concealed.

Despite the resemblance, however, they are distinct enough to be maintained as separate genera. The following dichotomy, together with the accompanying figures, should make it possible to distinguish the two species without much difficulty.

DICHOTOMY FOR SEPARATION OF *Ixodiphagus texanus* AND *Hunterellus hookeri*.

Head, viewed dorsally, very nearly or quite three times as broad as long; fronto-vertex nearly twice as broad as long and not flattened; ocellar triangle distinctly obtuse, the postocellar line much longer than a line from the anterior ocellus to a posterior ocellus; ocelli rather large, the ocellular line about equal to the diameter of an ocellus; *antennae inserted distinctly below middle of head and distinctly below a line connecting lower extremities of eyes*, the distance from antennal socket to anterior margin of clypeus equal to about half the distance between antennal sockets; *scape four or five times as long as thick, not expanded beneath*; antennal club of female obliquely truncate from base of second segment, subacute at apex; funicle joints of male antenna not longer than broad, the club 2-jointed and a little broader than the funicle joints; *labial palpi 3-jointed*, the second joint very short; maxillary palpi 4-jointed, the second and third joints each broader than long and shorter than either the first or last joint; mesoscutum and scutellum moderately convex, the scutellum polished except for very weak reticulation on the basal one third; angle between stigmal and postmarginal veins distinctly less than  $45^{\circ}$ ; antennae fusco-testaceous; tibiae and tarsi nearly uniformly testaceous, as are also the trochanters and apices of femora; wing subhyaline.

*Ixodiphagus texanus* Howard.

Head viewed dorsally, about twice as broad as long; fronto-vertex in the female not twice as broad as long, flattened and more or less horizontal, in the male more transverse than in the female but usually not so short as in *I. texanus*; ocellar triangle large, the postocellar line only a little longer than a line from the anterior to a posterior ocellus; ocelli not large and the lateral ones separated from the eye margin by a distance greater than the diameter of an ocellus; *antennae inserted at about the middle of head, slightly above the lower extremities of eyes*, the distance from antennal socket to anterior margin of clypeus approximately equal to the distance between antennal sockets; *scape not over three times as long as broad, with a distinct flange-like expansion on the inner side beneath*: club not strongly obliquely truncate, more rounded at apex; funicle joints in the male all distinctly longer than broad; *labial palpi 2-jointed*; maxillary palpi either 3- or 4-jointed (the third and fourth joints most often distinctly separated but frequently completely joined together), when 4-jointed the second and third joints subequal and always distinctly longer than broad; mesoscutum and scutellum flattened, the scutellum weakly reticulated or shagreened on at least the basal two thirds; angle formed by stigmal and postmarginal veins approximately  $45^{\circ}$ ; antennae dark brown to blackish, the scape usually fusco-testaceous; legs brownish black with the trochanters, knees, apices of tibiae and the tarsi reddish testaceous, the middle and hind tibiae always dark brownish or blackish except at base and apex; forewing subhyaline but usually with the area embracing the oblique hairless streak more or less distinctly stained with fuscous.

*Hunterellus hookeri* Howard.

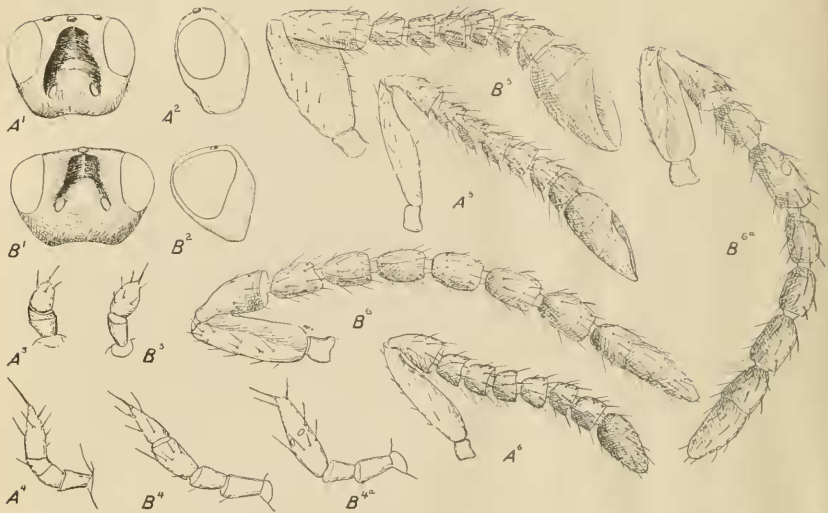


Fig. 1.—A. *Ixodiphagus texanus* Howard. 1, Front view of head; 2, side view of head; 3, labial palpus; 4, maxillary palpus; 5, antenna of female; 6, antenna of male.

B. *Hunterellus hookeri* Howard. 1, Front view of head; 2, side view of head; 3, labial palpus; 4, maxillary palpus, normal; 4a, maxillary palpus (third and fourth joints connate); 5, antenna of female; antenna of male, normal; 6a, other antenna from same individual as 6, abnormal.

#### *Ixodiphagus texanus* Howard.

This species was originally described in 1907 (*I*) from several females reared from nymphs of *Haemaphysalis leporis-palustris* (Packard) taken on wild rabbits in Jackson County, Tex. Although the species has been mentioned frequently in literature there is to date no published record of its again having been reared or collected.

The original type material of *I. texanus* in the U. S. National Museum is in poor condition and as a consequence the identity of the species was in some doubt until recently. In April, 1933, a consignment of twenty specimens was received for identification from R. A. Cooley through F. C. Bishopp, the labelling of which was as follows: "Parasite on *Ixodes hexagonus* var. *cookei* Packard on woodchuck, Mayfield, Idaho, June 28, 1932. Reared through fourth generation from the original. Bishopp No. 20657." All of the specimens were labeled alike. Eleven specimens of this lot were identified by the writer as *Hunterellus hookeri* and the other nine specimens as *Ixodiphagus texanus*.

The material was also examined by C. F. W. Muesebeck, who concurred in the identifications.

In the absence of a complete history of the specimens involved, it is impossible to explain the obvious contradiction between these identifications and the above indicated labeling. The two species of parasites are distinguished by good structural characters and can not be progeny of the same parents. Unless some mistake was made in labeling a part of the specimens, it appears certain either that the original stock of parasites comprised two species which were carried along together through the fourth generation or else that there was some contamination introduced in the course of the breeding work. Following the discovery that two species were involved, Dr. Bishopp obtained from Prof. Cooley and submitted to the writer for examination several specimens said to be the original stock from which the experiment was started. Whether or not this material included the actual parents used in starting the experiment, or constituted merely a part of the original rearing from a tick on a woodchuck taken at Mayfield, Idaho, from which the original parents were selected, the writer was not informed, but since the specimens submitted apparently emerged from the same individual tick nymph as did the parent stock, it appears practically certain that the specimens used as parents were of the same species. All of the specimens submitted proved to be *Hunterellus hookeri*. It therefore appears certain that the experiment was started with this species alone and that *Ixodiphagus texanus* was introduced later by accident, perhaps upon some animal used as host to the ticks. According to Fred A. Morton (18) rabbits were used for quantity production of ticks in the laboratory, and since the original host of *I. texanus* was *Haemaphysalis leporis-palustris*, the rabbit tick, it is possible that a parasitized tick of this species may have been inadvertently introduced on one of these animals. Whatever the explanation, it is to be questioned whether the specimens of *I. texanus* actually had as their original host *Ixodes hexagonus* var. *cookei* as indicated by the labeling. Likewise the locality from which the specimens came can not be stated definitely.

#### **Hunterellus hookeri** Howard.

Syn. *Ixidophagus caucurtei* Buysson.

*Hunterellus hookeri* was described in 1908 (2) from four females and six males reared from nymphs of *Rhipicephalus texanus* Banks (now recognized as a synonym of *R. sanguineus* Latreille) collected on a dog at Corpus Christi, Tex. *Ixidophagus caucurtei* was proposed in 1912 (5), being based upon specimens reared by E. Brumpt from nymphs of *Ixodes ricinus* Linnaeus taken on deer at Chantilly and at Fontainebleau, France.

As already stated, *H. hookeri* and *I. caururtei* are believed to be identical. This opinion is based upon a comparative study of authentic material in the U. S. National Museum. Included in this material are the types and many other undoubted specimens of *H. hookeri* from Texas and other parts of the United States as well as the following representatives of *I. caururtei*: A series of 21 specimens reared from *Ixodes ricinus* by E. Brumpt at Paris, France; a large series received from S. B. Wolbach, reared from *Rhipicephalus sanguineus* collected in the Forest of Fontainebleau, France; and a third large series received through J. Bequaert and representative of the French stock which was first introduced on Naushon Island, Mass., and later into Montana and Dewees Island, S. C. The types of *I. caururtei* in the Museum of Natural History in Paris were also examined by the writer in 1927, but these were not before him when the comparative study was made. The *caururtei* material mentioned differs in no discernible way from typical *Hunterellus hookeri*. The development and habits as recorded by H. P. Wood for *hookeri* (4) and by Brumpt (6), Cooley (17), and others for *caururtei* seem to agree. Both have been shown freely to attack closely related and in some instances the same species of ticks. There is no apparent reason to doubt, therefore, that the two names represent the same widely distributed species.

*Hunterellus hookeri* together with its synonym has received frequent mention in literature. According to C. P. Lounsbury (3) an unsuccessful attempt was made to introduce it into South Africa in 1908. In 1911 H. P. Wood (4) gave an account of its life history as a parasite of *Rhipicephalus sanguineus* Latreille in Texas and recorded it also as having been reared from *Dermacentor parumapertus marginatus* Banks collected at Green Valley, Calif.; from *R. sanguineus* at Monterey, Mexico; and from the same host taken at Lourenço Marques, Portuguese East Africa. E. Brumpt (6), in 1913, gave details of its life history in France as a parasite of *Ixodes ricinus* Linnaeus, stated that it also attacked *Haemaphysalis concinna* Koch in nature, and reared it experimentally through *Dermacentor reticulatus* Fabricius, *D. venustus* Banks (= *andersoni* Stiles), and *R. sanguineus*. A paper by A. E. Shipley (7) in 1914, entitled "Insects and War," mentioned *Ixodiphagus caururtei* as a ubiquitous enemy of all kinds of ticks. In 1915 A. da Costa Lima (8) recorded the taking of *Hunterellus hookeri* at Rio de Janeiro, Brazil, as a parasite of ticks on a dog. Nuttall, Warburton, and Cooper (9) in their monograph of ticks mention the parasite records by Howard and Brumpt. In 1922 P. H. Timberlake (10) exhibited before the Hawaiian Entomological Society specimens of *hookeri* said to have been taken on a dog at Coimbatore, South India, and in 1923 G. N. Wolcott (11)

recorded the species infesting *Dermacentor nitens* Neumann in Porto Rico.

R. A. Cooley (12), in 1927, gave an account of the introduction of *I. caucurtei* into the United States at Naushon Island, Mass., for the purpose of combating the dog tick, *Dermacentor variabilis* Say, and outlined plans for its introduction into Montana to combat the Rocky Mountain spotted fever tick, *D. andersoni* Stiles. A very similar paper, published the same year by Cooley (12a), further discussed the same subjects and gave a brief review of literature together with a summary of the life history of the French parasite. The following year F. Larrouse, A. G. King, and W. B. Wolbach (13) contributed a short account of the Naushon Island experiment in which the introduced parasite was shown to have survived the New England winter, field collections of both *D. variabilis* and *Ixodes scapularis* Say having yielded the parasite. The same year Cooley (14) stated that under certain circumstances this parasite would oviposit in fed larvae of *D. andersoni*, but that when eggs were deposited in a larva development was delayed until the tick reached the nymphal stage. A series of articles published in 1929 in the Seventh Biennial Report of the Montana State Board of Entomology by R. A. Cooley (15, 16), Fred A. Morton (17), and J. R. Parker and W. J. Butler (18) discussed various phases of the tick-parasite work at the Hamilton laboratory and reviewed the previous work of others. The previous record by Wood of *Rhipicephalus sanguineus* as host to *Hunterellus hookeri* at Lourenço Marques, Portuguese East Africa, was stated by Cooley (16, p. 17) to refer to *R. evertsi* Neumann instead of *sanguineus* and two new distribution records based upon material in the United States National Museum were cited, viz.: Indo-China, bred from dog tick by E. Roubaud; and Havana, Cuba, from unidentified nymphal ticks collected by Dr. Etchegoyhen. Later in the same year Cooley (19) gave a short summary of tick parasite studies and recorded the rearing of what was probably *H. hookeri* from *Haemaphysalis leachi* (Audouin) collected at Durban, Natal, and from *Hyalomma aegyptium impressum* Koch taken in the Pretoria district of South Africa. The article already referred to as having been published in 1930 by Cooley (20) states that a parasite closely related to and possibly identical with *caucurtei* had been discovered in the Transvaal preying on *Hyalomma aegyptium* Linnaeus. In 1931, C. B. Philip (22, 23) announced the rearing of *H. hookeri* from nymphs of *R. sanguineus* taken on dogs at Apapa, near Lagos, Nigeria, in West Africa. A paper by J. MacLeod (24, p. 398) in 1932 on the bionomics of the sheep tick, *Ixodes ricinus*, stated that over a thousand nymphs of this tick taken in England showed no parasitization by *I. caucurtei* or any other species. In 1933 Cooley (25) again discussed briefly the work with *I. caucurtei* in Montana.

From this brief review of the literature it will be seen that *Hunterellus hookeri* is known to attack a large number of species of ticks and that it has been recorded from Texas, California, Massachusetts, Montana, Cuba, Puerto Rico, Mexico, Brazil, France, Portuguese East Africa, Natal, the Transvaal, Nigeria, Indo-China, and India. Specimens representative of all of these locality records except the ones from Mexico, Brazil, Natal, Transvaal, and Nigeria are now in the National Museum collection and have been reviewed in the preparation of these remarks. The same collection contains specimens representing the following as yet unpublished records: A large series of specimens from South Miami, Fla., reared from *Rhipicephalus sanguineus* in 1931, under Bishopp Nos. 18033, 18184, 18187 and 16097; two specimens from Charleston, S. C., reared from *Dermaacentor variabilis*, Oct. 15, 1931, under Bishopp No. 18183; and one specimen from Ravalli County, Mont., said to have been reared from the nest of a magpie by W. L. Jellison, June 3, 1932. To these may be added the record already referred to in the discussion of *Ixodiphagus texanus*, of *Hunterellus hookeri* reared from *Ixodes hexagonus* var. *cookei* taken at Mayfield, Idaho, on a woodchuck.

The wide distribution of this species may be accounted for by its propensity for attacking the ticks of domesticated animals, especially dog ticks. In view of this well authenticated habit, it seems reasonable to suspect that its distribution may be even more general than indicated by the foregoing records, and the suggestion is offered that before further attempts to introduce the species into other regions or areas are undertaken, careful investigation should first be made to determine whether or not the species is already present in the area under consideration.

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